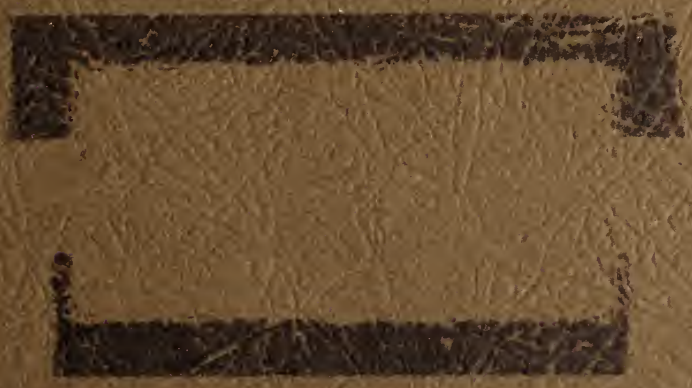
HOLMAN, M.

A STUDY OF ATTENDANCE AND ACHIEVEMENT IN ARITHMETIC, READING AND LANGUAGE OF VANNED AND UNVANNED PUPILS IN CERTAIN CENTRALIZED SCHOOLS OF ALBERTA



THE UNIVERSITY OF ALBERTA

A STUDY OF ATTENDANCE AND ACHIEVEMENT IN ARITHMETIC, READING AND LANGUAGE OF VANNED AND UNVANNED PUPILS IN CERTAIN CENTRALIZED SCHOOLS OF ALBERTA

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TABLE OF CONTENTS

CHAPTER		PAGE
I.	INTRODUCTION	1
	THE PROBLEM	2
	RELATED STUDIES	3
II.	EXPERIMENTAL DESIGN	5
	THE TESTS	6
	THE SAMPLE	7
III.	STATISTICAL TREATMENT	10
	TEST OF LINEARITY	12
	TEST OF HOMOSCEDASTICITY	12
	TEST OF HOMOGENEITY	12
	TEST OF NORMALITY	13
	ANALYSIS OF COVARIANCE	13
IV.	ANALYSIS OF THE GRADE TWO DATA	15
V.	ANALYSIS OF THE GRADE FOUR DATA	21
VI.	ANALYSIS OF THE GRADE SIX DATA	27
VII.	ATTENDANCE OF VANNED AND UNVANNED PUPILS	35
VIII.	CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER STUDY	37
	EFFECTS OF VANNING ON ACHIEVEMENT OF GRADE TWO PUPILS IN ARITHMETIC AND READING	37
	EFFECTS OF VANNING ON ACHIEVEMENT OF GRADE FOUR PUPILS IN ARITHMETIC AND READING	38
	EFFECTS OF VANNING ON ACHIEVEMENT OF GRADE SIX PUPILS IN ARITHMETIC, READING AND LANGUAGE	39

CHAPTER PAGE

ATTENDANCE 40

DISCUSSION 40

BIBLIOGRAPHY 46

APPENDIX

A. SAMPLE CALCULATION OF LINEARITY TEST 47

B. SAMPLE CALCULATION OF THE TEST OF HOMOSCEDASTICITY .. 51

C. SAMPLE CALCULATION OF THE TEST OF HOMOGENEITY OF VARIANCE 53

D. SAMPLE CALCULATION OF THE TEST OF NORMALITY 55

E. SAMPLE CALCULATION OF THE TEST OF COVARIANCE 57

F. SUMMARY OF PRELIMINARY COMPUTATIONS FOR THE ANALYSIS OF COVARIANCE AND GROUP MEANS 62

LIST OF TABLES

TABLE		PAGE
I.	Reliability Coefficients for the Stanford Achievement Test	7
II.	Number of Grade Two, Four and Six Students Selected from Four Alberta School Divisions	8
III.	Linearity of Regression Between First and Second Testing in Arithmetic of 171 Vanned Grade Two Pupils	15
IV.	Linearity of Regression Between First and Second Testing in Arithmetic of 144 Unvanned Grade Two Pupils	15
V.	Linearity of Regression Between First and Second Testing in Reading of 171 Vanned Grade Two Pupils	16
VI.	Linearity of Regression Between First and Second Testing in Reading of 144 Unvanned Grade Two Pupils	16
VII.	Homogeneity of Variance of 171 Vanned and 144 Unvanned Grade Two Pupils in Arithmetic	18
VIII.	Homogeneity of Variance of 171 Vanned and 144 Unvanned Grade Two Pupils in Reading	18
IX.	Analysis of Covariance Summary of 171 Vanned and 144 Unvanned Grade Two Pupils in Arithmetic	19
X.	Analysis of Covariance Summary of 171 Vanned and 144 Unvanned Grade Two Pupils in Reading	20
XI.	Linearity of Regression Between First and Second Testing in Arithmetic of 188 Vanned Grade Four Pupils	21
XII.	Linearity of Regression Between First and Second Testing in Arithmetic of 160 Unvanned Grade Four Pupils	21
XIII.	Linearity of Regression Between First and Second Testing in Reading of 188 Vanned Grade Four Pupils	22
XIV.	Linearity of Regression Between First and Second Testing in Reading of 160 Unvanned Grade Four Pupils	22

TABLE		PAGE
XV.	Homogeneity of Variance of 188 Vanned and 160 Unvanned Grade Four Pupils in Arithmetic	24
XVI.	Homogeneity of Variance of 188 Vanned and 160 Unvanned Grade Four Pupils in Reading	24
XVII.	Analysis of Covariance Summary of 188 Vanned and 160 Unvanned Grade Four Pupils in Arithmetic	25
XVIII.	Analysis of Covariance Summary of 188 Vanned and 160 Unvanned Grade Four Pupils in Reading	26
XIX.	Linearity of Regression Between First and Second Testing in Arithmetic of 167 Vanned Grade Six Pupils	27
XX.	Linearity of Regression Between First and Second Testing in Arithmetic of 143 Unvanned Grade Six Pupils	27
XXI.	Linearity of Regression Between First and Second Testing in Reading of 167 Vanned Grade Six Pupils	28
XXII.	Linearity of Regression Between First and Second Testing in Reading of 143 Unvanned Grade Six Pupils	28
XXIII.	Linearity of Regression Between First and Second Testing in Language of 167 Vanned Grade Six Pupils	29
XXIV.	Linearity of Regression Between First and Second Testing in Language of 143 Unvanned Grade Six Pupils ...	29
XXV.	Homogeneity of Variance of 167 Vanned and 143 Unvanned Grade Six Pupils in Arithmetic	31
XXVI.	Homogeneity of Variance of 167 Vanned and 143 Unvanned Grade Six Pupils in Reading	31
XXVII.	Homogeneity of Variance of 167 Vanned and 143 Unvanned Grade Six Pupils in Language	32
XXVIII.	Analysis of Covariance Summary of 167 Vanned and 143 Unvanned Grade Six Pupils in Arithmetic	33
XXIX.	Analysis of Covariance Summary of 167 Vanned and 143 Unvanned Grade Six Pupils in Reading	33

TABLE		PAGE
XXX.	Analysis of Covariance Summary of 167 Vanned and 143 Unvanned Grade Six Pupils in Language	34
XXXI.	Summary of Tests of Homogeneity of Variance of Attendance for Grades Two, Four and Six	34
XXXII.	Summary of Results of Tests Measuring Differences Between Mean Attendance of Vanned and Unvanned Groups	35
XXXIII.	Summary of Results for Grade Two Groups	37
XXXIV.	Summary of Results for Grade Four Groups	38
XXXV.	Summary of Results for Grade Six Groups	39
XXXVI.	Summary of Preliminary Computation Necessary for the Analysis of Covariance	58
XXXVII.	Summarization of Initial Steps in the Analysis of Covariance	59
XXXVIII.	The Summary of Residual Sums of Squares as Calculated For Analysis of Covariance	61
XXXIX.	Summary of Preliminary Computation For the Analysis of Covariance For Grade Two	63
XL.	Summary of Preliminary Computation For the Analysis of Covariance For Grade Four	63
XLI.	Summary of Preliminary Computation For the Analysis of Covariance For Grade Six	64
XLII.	Summary of the Means For the Grade Two Pupils	64
XLIII.	Summary of the Means For the Grade Four Pupils	65
XLIV.	Summary of the Means For the Grade Six Pupils	65

LIST OF FIGURES

FIGURE		PAGE
1.	Sample Correlation Table For Grade Two Vanned Reading	50

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The writer wishes to express his appreciation to Dr. G. M. Dunlop and Stephen N. Hunka for their helpful guidance and assistance during the preparation of this study.

SYNOPSIS

The main aim of this study was to investigate the effects of vanning on the achievement of grade two, four and six pupils in arithmetic, reading and language.

Using two forms of the Stanford Achievement Test as measuring instruments, tests were administered at appropriate grade levels to a number of pupils who were vanned to school and to a comparable number who were not.

Since the two groups could not be equated at the beginning of the experiment, the data were treated statistically using the analysis of covariance technique. The assumptions necessary for the validity of the covariance analysis were also tested.

The findings indicated that there was a significant difference in achievement in arithmetic and reading in favor of the unvanned grade two pupils and a significant difference in arithmetic achievement favoring the vanned grade four pupils. There appeared to be no differences between the two groups in grade four reading achievement. At the grade six level there were no significant differences in arithmetic, reading and language achievement of the two groups.

Since all the prerequisite assumptions for analysis of covariance could not be fully satisfied, the findings were treated with some reservation.

The computation for the comparison of attendance was based on a critical ratio. To justify this analysis the homogeneity of variance

was tested and confirmed. The findings indicated that there was a significant difference in attendance in favor of the grade six unvanned group.

CHAPTER I

INTRODUCTION

During the past twenty years the pattern of school organization in Alberta has kept pace with the province's growth and development. Small ungraded schools have been closed and the pupils transported to larger schools at central points. This consolidation or centralization of schools has been accelerated by such factors as the teacher shortage, unwillingness of teachers to work in isolated areas and the public demand for a level of rural education comparable to that found in city systems.

Consolidation of schools and services has permitted a more complete educational program for rural areas. It has also made possible increased provision for courses leading to graduation from grade twelve with a high school diploma or senior matriculation standing.

To transport rural children to centralized schools it has become the accepted practice for school authorities to operate fleets of school vans. In the school year ending in 1957 the school divisions and counties of this province transported 66,823 pupils over a distance of 113,056 miles per day at an annual cost of $6,478,981.48.[1]

Operating under this centralized organization divisional boards have striven to equalize the educational opportunities of rural pupils and pupils in cities and towns. To avail themselves of extended

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[1]Department of Education for the Province of Alberta, Fifty-second Annual Report, 1956, Table No. 32.

opportunities rural pupils must daily spend varying periods of time in school vans in addition to time spent during regular hours of school. This lengthening of the school day might be expected to have an adverse effect upon the achievement of rural pupils. Since vanning has become an accepted practice for the majority of rural students, it would appear desirable to obtain some reliable information on the effects of vanning upon scholastic achievement.

THE PROBLEM

Is the vanning of pupils to centralized schools prejudicial to their achievement, health or attendance? The answer to this problem is of vital concern to parents, teachers and boards of trustees. Educational literature does not give us too clear an answer to the question. As a consequence it was decided to conduct a rather extensive study of the problem in four rural divisions in order to arrive at a definite finding which might guide the thinking of those responsible for the establishment and maintenance of van routes in centralized school areas.

RELATED STUDIES

A study of existing research as reviewed by the Encyclopedia of Educational Research[2] and the Education Index[3] does not reveal any studies

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[2] W. S. Monroe. Encyclopedia of Educational Research, New York: The Macmillan Company, 1952.

[3] The Education Index, The H. W. Wilson co., New York, N.Y.

relating transportation of pupils to educational achievement. Most of the studies listed pertain to various phases of transportation such as driver selection, safety standards, bus routes and finance.

Andrews,[4] reporting in the Alberta School Trustee, states that during a four-year period following the consolidation of schools in the Lamont School Division the number of grade nine failures was reduced by thirty-seven per cent. Since these comparisons are more directly related to the advantages of consolidation of schools than to the effects of transportation on academic achievement their value is limited.

A study by Lambert[5] indicates that the length of the school day is increased for children who are transported to school, but gives no indication of the effect of vanning upon educational achievement.

Lee's[6] English study revealed a greater incidence of maladjustment in transported children than in those who were not transported, and that adjustment became increasingly poorer with increase in age. Poor adjustment at school usually has an adverse effect upon educational achievement; however, Lee's study did not attempt to measure the educational achievement of the two groups.

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[4] A. G. Andrews. "Centralization in the Lamont Division," Alberta School Trustee, November, 1952.

[5] A. C. Lambert. "Length of School Day for Transported Pupils," American School Board Journal, September, 1953.

[6] T. Lee. "On the Relation Between School Journey and Social and Emotional Adjustment in Rural Infant Children." British Journal of Educational Psychology, June 1957, p. 101 - 114.

In our own province a recent study conducted in four school divisions adjacent to Calgary compared achievement of vanned and unvanned pupils at the grade two, four and six levels using the appropriate forms of the Stanford Achievement Test as measuring instruments. From this study Hunka[7] found that there was a significant difference in educational achievement over a fourteen month period between vanned and unvanned grade two children with the results favoring the unvanned group. At the grade four and six levels there was no significant difference in achievement between the vanned and the unvanned groups.

This study compares the achievement of vanned and unvanned pupils in arithmetic, reading and language at three grade levels. It also attempts to determine if there is a significant difference in school attendance between the two groups.

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[7] S. Hunka. "The Effects of Bus Transportation on Pupil Achievement," Master's Thesis, University of Alberta, September, 1957.

CHAPTER II

EXPERIMENTAL DESIGN

An investigation of the school achievement of rural pupils in four school divisions of the Calgary area was conducted between January 1956 and April 1957, by The Committee on Educational Research, Faculty of Education, University of Alberta. The main study called for the testing of two hundred pupils (in each of grades two, four and six) who were vanned to school daily, and an equivalent number of pupils (at the same grade levels) who did not require transportation. Division of the pupils in each grade into control and experimental groups was determined by the transportation factor.

The Stanford Achievement Tests and Otis Quick Scoring Tests of Mental Ability were used to give quantitative measures of educational achievement and intelligence for the control and experimental groups. Information regarding attendance was obtained from personal data sheets compiled by the teachers.

THE TESTS

To determine the gains in educational achievement forms K and J of the Primary, Elementary, Intermediate Partial and Advanced Partial batteries of the Stanford Achievement Tests were administered at the appropriate grade levels. To assure uniformity the scoring of the papers and tabulation of results were carried out at the Faculty of Education.

The Primary battery of the Stanford Achievement Test consists of

five subtests: Paragraph Meaning, Word Meaning, Spelling, Arithmetic Computation and Arithmetic Reasoning. A subtest in Language is added to the Elementary, Intermediate Partial and Advanced Partial batteries.

Grade scores for each subtest were obtained from the raw scores of the Stanford Achievement Test and the scores from the respective subtests were combined to give average scores in reading and arithmetic in grades two and four, and in reading, arithmetic and language in grade six. These scores, multiplied by ten to facilitate calculation, were used for the statistical analysis in this study.

The designers of the Stanford Achievement Test state that the test is a good measure of pupil achievement in commonly accepted basic skills and understandings. Hanna and Norcross[8] agree that the spelling, word usage and arithmetic content of the Stanford Achievement Test are quite adequate; however, they also indicate that the reading section of the test could be improved by better selection of content.

Reliability coefficients for the various subtests within the

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[8] P. R. Hanna and C. E. Norcross, "Stanford Achievement Tests." Fourth Mental Measurement Year Book, edited by O. K. Buros, Gryphen Press, N.J., 1953, p. 26.

Stanford Achievement Tests appear in Table I.

TABLE I

RELIABILITY COEFFICIENTS FOR THE STANFORD ACHIEVEMENT TEST

Test	2	3	4	5	6	7
Paragraph Meaning	.956	.912	.898	.886	.920	.841
Word Meaning	.912	.909	.924	.915	.917	.907
Spelling	.945	.953	.946	.926	.933	.941
Language		.868	.869	.795	.818	.820
Arithmetic Reasoning	.788	.905	.933	.908	.899	.897
Arithmetic Computation	.878	.893	.900	.851	.893	.890

The designers of the Stanford Achievement Test claim that "the reliability coefficients indicate that the tests are yielding results of satisfactory dependability and consistency."[9]

THE SAMPLE

Two groups of children of approximately two hundred in each group at the grade two, four and six levels were obtained from the population of four school divisions in the Calgary area. One of the groups at each grade level was conveyed to school by vans; the other was not.

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[9] Ibid., Primary Manual, p. 12.

The children in the vanned group resided on farms and in hamlets. The unvanned group resided in towns and small villages in which centralized schools were operating.

Initially the plan called for the testing of two hundred children in each grade and group. To obtain this number all the children at the grade two, four and six levels were tested in January 1956 and again in April 1957. During the fourteen month period it was found that some children had moved away and that for many others there were incomplete sets of scores. Consequently it was not possible to retain the original sample size.

Table II indicates the numbers of students in the control and experimental groups with scores sufficiently complete for inclusion in this study.

TABLE II

NUMBER OF GRADE TWO, FOUR, AND SIX STUDENTS SELECTED FROM FOUR ALBERTA SCHOOL DIVISIONS

Group	Vanned	Unvanned
Grade II	171	144
Grade IV	188	160
Grade VI	167	143
Total	526	447

The main study was concerned with an analysis of the differences in educational achievement between the vanned and unvanned groups at the three grade levels.

This study is concerned with an analysis of the differences in educational achievement of the same groups for each subject tested. The subjects are arithmetic and reading in grades two and four, and arithmetic, reading and language in grade six. It also attempts to determine if there is a significant difference in school attendance between the control and the experimental groups.

The null hypotheses to be tested by this study are:

1. There is no significant difference in educational achievement in arithmetic and reading in grades two and four, and in arithmetic, reading and language in grade six over a fourteen month period as measured by the Stanford Achievement Test as between children who travel to school on vans and those who do not.

2. There is no significant difference in the number of days of school attendance by pupils of grades two, four and six whether they travel by school van or not.

CHAPTER III

STATISTICAL TREATMENT

In the first study the analysis of covariance technique was used to compare the achievement of the experimental and control groups. This method was employed because it made possible comparisons which could not otherwise be made because of unequal groups.

In this study the January 1956 and April 1957 grade scores in arithmetic, reading and language, for both groups were used as the data for further analysis using the same technique.

The assumptions necessary for the validity of analysis of covariance procedure have been discussed by Hunka[10] and are listed below:

1. The measurements obtained are observed values (of random variables) distributed about three mean values.
2. The effects which contribute to the observed measurements are additive.
3. The observed measurements in each group have a common variance.
4. The observed values are normally distributed.
5. Scores distribute themselves with equal variance within the columns of a regression table when initial and final grade scores are correlated.
6. A linear relationship between initial and final grade scores is necessary.

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[10] S. Hunka. Master's Thesis, University of Alberta, 1957.

In practice it is extremely difficult to be assured that all the assumptions have been adequately met. However, the results of an experiment which does not fulfill all these conditions are not completely invalidated.

> Failure of any assumption will impair to some extent the standard properties on which the widespread utility of the technique depends. Since an experimenter could rarely, if ever, convince himself that all the assumptions were exactly satisfied in his data, the technique must be regarded as approximative rather than exact.[11]

The assumptions of normality of distribution were tested for both experimental and control groups at each grade level. The effects of non-normal populations upon the analysis of covariance appear to be relatively small but necessitate greater caution in interpreting the final results.

The remaining assumptions of homogeneity of variance, linearity of regression between initial and final scores and homoscedasticity also received statistical validation in this study.

TEST OF LINEARITY

A correlation table was constructed to determine whether there was a linear relationship between the initial and final grade scores. The correlation coefficient and correlation ratio were calculated, and from these sums of squares due to regression and about the regression line were computed. The ratio of the sums of squares was then compared

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[11] W. G. Cochran, "Some Consequences When the Assumptions for the Analysis of Variance are not Satisfied." Biometrics, March 1947, Vol. 3, No. 1, p. 37.

to the F distribution. A sample calculation is given in Appendix A. The results of the tests for linearity, homoscedasticity, homogeneity, normality and covariance appear in table form in Chapter VIII.

TEST OF HOMOSCEDASTICITY

Homoscedasticity is obtained when groups of observed scores are distributed with equal variance about a common regression line. This is evidenced by equal variance of test scores on the second testing of students who on the original testing had similar scores. The final analysis was made using Bartlett's Test and the chi-square distribution.[12] A sample calculation is given in Appendix B.

TEST OF HOMOGENEITY

The test of homogeneity of variance was made to determine whether there were any significant differences in the variability of grade scores about their group means. The variance of the final test scores of control and experimental groups were compared using Bartlett's Test and the chi-square distribution.[13] The importance of this test cannot be underestimated since significant differences in variability might lead to too frequent rejection of the null hypothesis. A sample calculation appears in Appendix C.

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[12] J. F. Kenny and E. S. Keeping, Mathematics of Statistics, Part Two (Toronto: D. Van Nostrand Company, 1953), p. 250.

[13] Ibid., p. 250.

TEST OF NORMALITY

The distribution of the final grade scores for the experimental and control groups were tested for normality. Frequencies were tabulated for selected class intervals and compared with theoretical expected frequencies using the chi-square distribution. A sample calculation appears in Appendix D.

ANALYSIS OF COVARIANCE

The analysis consists of estimating the variances of scores from the April 1957 testing of both groups, correcting these for the initial January 1956 scores, and then comparing the unbiased variance estimates by using the F. Test.

The steps followed in the computation of covariance analysis are listed below:

1. Sums of squares for control and experimental groups first and second testing were determined.

2. Sums of squares for control and experimental groups first and second testing respectively were combined.

3. Sums of squares between sample means were calculated. Since two means are necessary to establish the regression line of the means and since only two means were available, nothing remained to account for any sums of squares. The result of this calculation comes to zero and consequently was used as a check only.

4. Covariance between first and second testing of vanned and unvanned pupils was computed.

5. The sums of squares were calculated on the basis of a mean obtained from pooled first testing grade scores and pooled second testing grade scores.

6. Regression coefficients based on sums of squares in each group, combined sums of squares and pooled samples were calculated and used to modify the sums of squares determined by the second testing.

7. In the final analysis the following calculations were made:

   (a) Difference between control and experimental groups when group means were corrected by the use of group regression coefficients.

   (b) Differences between control and experimental groups when the group means were corrected on the basis of a combined or average regression coefficient.

   (c) Difference between group regression.

When 7(c) shows that there is a significant difference between individual regression lines, the combination of regression lines as used in 7(b) is not justified. When such occasions arise the results of 7(a) are to be considered more valid. The results in each case were tested with reference to the F distribution. A sample calculation is given in Appendix E.

CHAPTER IV

ANALYSIS OF THE GRADE TWO DATA

The results of the tests used to measure the linearity of the relationship between the January 1956 and April 1957 test scores in arithmetic and reading for vanned and unvanned grade two groups are contained in the tables which follow:

TABLE III

LINEARITY OF REGRESSION BETWEEN FIRST AND SECOND TESTING IN ARITHMETIC OF 171 VANNED GRADE TWO PUPILS

Variation	SS	DF	MS
About Regression Line	367.072	7	52.439
Due to Regression Line	3504.664	162	216.337
Total	3871.736		

F = 0.242

TABLE IV

LINEARITY OF REGRESSION BETWEEN FIRST AND SECOND TESTING IN ARITHMETIC OF 144 UNVANNED GRADE TWO PUPILS

Variation	SS	DF	MS
About Regression Line	159.544	6	26.591
Due to Regression Line	3703.109	136	27.299
Total	3862.653		

F = 0.976

TABLE V

LINEARITY OF REGRESSION BETWEEN FIRST AND SECOND TESTING IN READING OF 171 VANNED GRADE TWO PUPILS

Variation	SS	DF	MS
About Regression Line	953.599	12	79.467
Due to Regression Line	8105.594	157	51.628
Total	9039.193		

F = 1.539

TABLE VI

LINEARITY OF REGRESSION BETWEEN FIRST AND SECOND TESTING IN READING OF 144 UNVANNED GRADE TWO PUPILS

Variation	SS	DF	MS
About Regression Line	216.918	10	21.692
Due to Regression Line	9711.252	132	73.570
Total	9928.170		

F = 0.295

Results of the tests of linearity indicate that:

1. Linear relationships were evident between the initial and final scores on the Stanford Achievement Tests in arithmetic and reading for 171 vanned grade two pupils. The null hypothesis of linearity was accepted since F values of 0.242 and 1.539 could have occurred through chance error more frequently than five times out of one hundred.

2. Linear relationships were evident between the initial and final scores on the Stanford Achievement Tests in arithmetic and reading for 144 unvanned grade two pupils. The null hypothesis of linearity was accepted since F values of 0.976 and 0.295 could have occurred through chance error more frequently than five out of one hundred times.

On the basis of these results the assumption of linearity of grade scores for the vanned and unvanned groups in arithmetic and reading at the grade two level was accepted.

The test for homoscedasticity of the arithmetic and reading scores for the vanned group indicated that the chi-square values of 13.32 and 20.20 respectively were beyond the 5% level but not the 1% level of significance.

The test for homoscedasticity of the arithmetic and reading scores for the unvanned group indicated that the chi-square values of 31.94 and 29.91 respectively were well within the 1% level of significance.

The above tests would indicate that the variance of the scores obtained in the second testing of pupils who had similar scores on the first testing, was not consistent over a selected portion of the class intervals used in the correlation table. On this basis it was concluded that the grade scores in arithmetic and reading of the vanned and unvanned pupils were not distributed with consistency about their common regression line.

The tests of normality, which compared the observed distributions in arithmetic and reading in both the vanned and unvanned groups with a theoretical normal distribution, indicated that there was no reason to suspect that the frequencies observed were not normally distributed. Since none of the chi-square values reached the 5% level of significance, the observed distributions could have occurred because of errors of chance in

less than five cases out of a hundred. Therefore, the assumption of normality for covariance analysis was not seriously weakened.

The results of tests of homogeneity of variance of grade scores in arithmetic and reading for both vanned and unvanned pupils appear in Tables VII and VIII.

TABLE VII

HOMOGENEITY OF VARIANCE OF 171 VANNED AND 144 UNVANNED GRADE TWO PUPILS IN ARITHMETIC

Sample	n_k	S_k	S_k/n_k	$n_k \log S_k/n_k$
Vanned Final Test	170	7724.977	45.441	281.765
Unvanned Final Test	143	7970.556	55.738	249.702
Total	313	15695.533		531.467

M/c = 1.650

TABLE VIII

HOMOGENEITY OF VARIANCE OF 171 VANNED AND 144 UNVANNED GRADE TWO PUPILS IN READING

Sample	n_k	S_k	S_k/n_k	$n_k \log S_k/n_k$
Vanned Final Test	170	15146.526	89.097	331.447
Unvanned Final Test	143	15926.972	111.377	292.693
Total	313	31073.498		624.170

M/c = 1.930

The observed values of M/c, when compared to the values at the five per cent level of the distribution, indicated the tenability of the null hypothesis that variances in both groups are in effect the same.

The results of the analysis of covariance in arithmetic and reading for grade two pupils appear in Tables IX and X.

TABLE IX

ANALYSIS OF COVARIANCE SUMMARY OF 171 VANNED AND 144 UNVANNED GRADE TWO PUPILS IN ARITHMETIC

Test	Property Tested	F Ratio	Significant Ratio 5%	Significant Ratio 1%	Result
F_1	Difference between groups. Group means corrected for Group Regression	14.382	3.02	4.66	Significant 1%
F_2	Difference between groups. Group means corrected for Combined Regression	2.221	3.86	6.70	Not Significant
F_3	Difference between Group Regression	26.371	3.86	6.70	Significant 1%

Since the slopes of the regression lines were found to be significantly different, the use of a combined regression coefficient in F_2 is not justified. For this reason the results of F_1 were considered more valid than those of F_2.

On the basis of this analysis it was concluded that there was a significant difference in arithmetic achievement between 171 vanned and 144 unvanned pupils in grade two as measured over a fourteen month interval by the Stanford Achievement Test.

The null hypothesis that both groups in effect received the same treatment was rejected, since the observed scores could have occurred through errors of chance less than once in a hundred times.

TABLE X

ANALYSIS OF COVARIANCE SUMMARY OF 171 VANNED AND 144 UNVANNED GRADE TWO PUPILS IN READING

Test	Property Tested	F Ratio	Significant Ratio 5%	Significant Ratio 1%	Result
F_1	Difference between groups. Group means corrected for Group Regression	4.029	3.03	4.69	Significant 5%
F_2	Difference between groups. Group means corrected for Combined Regression	6.994	3.87	6.73	Significant 1%
F_3	Difference between Group Regression	1.059	3.87	6.73	Not Significant

On the basis of the above analysis it was concluded that there was a significant difference in reading achievement between 171 vanned and 144 unvanned grade two pupils as measured over a fourteen month interval by the Stanford Achievement Test.

CHAPTER V

ANALYSIS OF THE GRADE FOUR DATA

Results of the tests used to measure the linearity of the relationships between the January 1956 and April 1957 test scores for vanned and unvanned groups are contained in the tables which follow:

TABLE XI

LINEARITY OF REGRESSION BETWEEN FIRST AND SECOND TESTING IN ARITHMETIC OF 188 VANNED GRADE FOUR PUPILS

Variation	SS	df	MS
About Regression Line	455.053	13	35.004
Due to Regression Line	10978.160	173	63.457
Total	11433.213		

F = 0.552

TABLE XII

LINEARITY OF REGRESSION BETWEEN FIRST AND SECOND TESTING IN ARITHMETIC OF 160 UNVANNED GRADE FOUR PUPILS

Variation	SS	df	MS
About Regression Line	182.287	11	16.572
Due to Regression Line	8962.430	147	60.969
Total	9144.717		

F = 0.272

TABLE XIII

LINEARITY OF REGRESSION BETWEEN FIRST AND SECOND TESTING IN READING OF 188 VANNED GRADE FOUR PUPILS

Variation	SS	df	MS
About Regression Line	1660.730	17	97.690
Due to Regression Line	20606.611	169	121.933
Total	22267.341		

F = 0.801

TABLE XIV

LINEARITY OF REGRESSION BETWEEN FIRST AND SECOND TESTING IN READING OF 160 UNVANNED GRADE FOUR PUPILS

Variation	SS	df	MS
About Regression Line	1705.981	17	100.352
Due to Regression Line	21791.493	141	154.550
Total	23497.474		

F = 0.649

Results of the tests of linearity indicate that:

1. Linear relationships were evident between the initial and final scores on the Stanford Achievement Tests in arithmetic and reading for 188 vanned grade four pupils. The null hypothesis of linearity was accepted since F values of 0.552 and 0.801 could have occurred through chance error more frequently than five times out of one hundred.

2. Linear relationships were evident between the initial and

final scores on the Stanford Achievement tests in arithmetic and reading for 160 unvanned grade four pupils. The null hypothesis of linearity was accepted since F values of 0.272 and 0.649 could have occurred through chance errors more frequently than five out of one hundred times.

The assumption of linearity, based on the results of these tests was considered tenable at the grade four level for the vanned and unvanned groups in arithmetic and reading.

The tests for homoscedasticity for reading of the unvanned group and for arithmetic of the vanned group indicated that the performance variability between the test and retest did differ significantly. For the other two groups it was concluded that such deviations from the hypothesis of perfect homoscedasticity as did occur could be attributed to chance factors in sampling. Further analysis and conclusions from these data must then recognize the failure of the sample concerned to meet the test of comparability.

The test of normality comparing the observed distributions in arithmetic and reading in both vanned and unvanned groups with a theoretical normal distribution, indicated that there was no reason to suspect that the frequencies observed were not normally distributed, and that the differences that were noted could be attributed to chance factors in sampling. Therefore, the assumption of normality necessary for covariance analysis was considered tenable.

The tests of homogeneity of variance of grade scores in arithmetic and reading for both vanned and unvanned pupils appear in tables XV and XVI.

TABLE XV

HOMOGENEITY OF VARIANCE OF 188 VANNED AND 160
UNVANNED GRADE FOUR PUPILS IN ARITHMETIC

Sample	n_k	S_k	S_k/n_k	$n_k \log S_k/n_k$
Vanned Final Test	187	19010.187	101.659	375.338
Unvanned Final Test	159	15453.500	97.192	316.033
Total	346	34463.687		691.371

M/c = 0.827

TABLE XVI

HOMOGENEITY OF VARIANCE OF 188 VANNED AND 160
UNVANNED GRADE FOUR PUPILS IN READING

Sample	n_k	S_k	S_k/n_k	$n_k \log S_k/n_k$
Vanned Final Test	187	33759.490	180.532	421.975
Unvanned Final Test	159	32270.400	202.958	366.878
Total	346	66029.890		788.853

M/c = 0.592

The observed value of M/c fails to satisfy the null hypothesis at the 5% level of confidence; therefore, we can conclude that variances in both groups for arithmetic and reading were the same, and any differences that did occur were due to chance errors.

The results of the analysis of covariance in arithmetic and reading for grade four pupils appear in Tables XVII and XVIII.

TABLE XVII

ANALYSIS OF COVARIANCE SUMMARY OF 188 VANNED AND 160 UNVANNED GRADE FOUR PUPILS IN ARITHMETIC

Test	Property Tested	F Ratio	Significant Ratio 5%	Significant Ratio 1%	Result
F_1	Difference between groups Group means corrected for Group Regression	19.25	3.02	4.66	Significant 1%
F_2	Difference between groups Group means corrected for Combined Regression	----	3.86	6.70	Not Significant
F_3	Difference between group regressions	38.45	3.86	6.70	Significant 1%

In the above covariance table the F_1 test indicated that the null hypothesis of equality of treatment must be rejected at the 1% level of significance. The F_2 test was not applicable since the F_3 test indicated that the combining of regression coefficients was not justified. It was then concluded that there was a significant difference in arithmetic achievement in favor of the vanned group as measured by the Stanford Achievement Test over a fourteen month period.

TABLE XVIII

ANALYSIS OF COVARIANCE SUMMARY OF 188 VANNED AND 160 UNVANNED GRADE FOUR PUPILS IN READING

Test	Property Tested	F Ratio	Significant Ratio 5%	1%	Result
F_1	Difference between groups Group means corrected for Group Regression	2.400	3.02	4.66	not significant
F_2	Difference between groups Group means corrected for combined regression	2.137	3.86	6.70	not significant
F_3	Difference between Group Regressions	2.637	3.86	6.70	not significant

An analysis of table XVIII indicates that there was no significant difference between 188 vanned and 160 unvanned grade four pupils in reading achievement as measured by the Stanford Achievement Test over a fourteen month period.

The superior achievement in arithmetic of the vanned grade four group is not too disturbing when compared with Hunka's[14] findings. His study indicated a near significant difference in total achievement at the grade four level in favor of the vanned group. It may be reasonable to attribute a large measure of this almost significant difference in total achievement to the arithmetic sub-test of the total battery.

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[14] S. Hunka. "The Effects of Bus Transportation on Pupil Achievement." Master's Thesis, University of Alberta, September, 1957.

CHAPTER VI

ANALYSIS OF THE GRADE SIX DATA

Tests of Linearity for the vanned and unvanned groups in arithmetic, reading and language are summarized in the tables which follow:

TABLE XIX

LINEARITY OF REGRESSION BETWEEN FIRST AND SECOND TESTING IN ARITHMETIC OF 157 VANNED GRADE SIX PUPILS

Variation	SS	df	MS
About Regression Line	67.244	15	4.483
Due to Regression Line	2062.156	150	13.748
Total	2129.400		

F = 0.326

TABLE XX

LINEARITY OF REGRESSION BETWEEN FIRST AND SECOND TESTING IN ARITHMETIC OF 143 UNVANNED GRADE SIX PUPILS

Variation	SS	df	MS
About Regression Line	262.274	15	17.485
Due to Regression Line	14366.780	126	114.022
Total	14629.054		

F = 0.153

TABLE XXI

LINEARITY OF REGRESSION BETWEEN FIRST AND SECOND TESTING IN READING OF 167 VANNED GRADE SIX PUPILS

Variation	SS	df	MS
About Regression Line	8783.432	23	381.888
Due to Regression Line	33106.781	142	233.146
Total	41890.213		

F = 1.638

TABLE XXII

LINEARITY OF REGRESSION BETWEEN FIRST AND SECOND TESTING IN READING OF 143 UNVANNED GRADE SIX PUPILS

Variation	SS	df	MS
About Regression Line	4120.717	20	206.036
Due to Regression Line	24477.037	121	202.290
Total	28597.774		

F = 1.019

TABLE XXIII

LINEARITY OF REGRESSION BETWEEN FIRST AND SECOND TESTING IN LANGUAGE OF 167 VANNED GRADE SIX PUPILS

Variation	SS	df	MS
About Regression Line	12532.515	18	696.251
Due to Regression Line	38224.171	149	256.538
Total	50756.686		

D = 2.714

TABLE XXIV

LINEARITY OF REGRESSION BETWEEN FIRST AND SECOND TESTING IN LANGUAGE OF 143 UNVANNED GRADE SIX PUPILS

Variation	SS	df	MS
About Regression Line	5512.355	15	367.490
Due to Regression Line	39373.963	126	312.492
Total	44886.318		

F = 1.176

Results of the tests of linearity indicate that:

1. Linear relationships were evident between the initial and final scores on the Stanford Achievement Test in arithmetic for the vanned and unvanned group, in reading and language for the unvanned group. On the basis of these test results the null hypothesis that there exists a linear relationship was accepted.

2. Non-linear relationships were evidenced between the initial and final scores in reading and language for the vanned group. The null hypothesis was rejected at the 5% level of significance for reading and at the 1% level for language. The results of the tests indicating non-linearity for the reading and language subjects in the vanned groups places some doubt upon the validity of using the assumption of linear regression as the basis for equating these groups for their initial test scores.

Results of tests measuring the degree of homoscedasticity for reading and language in the unvanned group indicated that there was no reason to suspect significantly different variances of second testing scores for pupils who had similar scores on the initial testing. However, the contrary was observed for reading and language scores for the vanned group and for arithmetic scores in both the vanned and unvanned groups.

The tests of normality which compared the observed distributions in arithmetic, reading and language in both vanned and unvanned groups to a theoretical normal distribution indicated the following results:

1. There was no reason to suspect that the distribution of grade scores in arithmetic for the vanned and unvanned groups and the reading scores in the vanned group was not normal.

2. There were definite indications that the reading grade scores for the unvanned group and the language grade scores for both vanned and unvanned groups, were not normally distributed.

The results of tests of homogeneity of variance of grade scores in arithmetic, reading and language for both vanned and unvanned pupils appear in tables XXV, XXVI and XXVII.

TABLE XXV

HOMOGENEITY OF VARIANCE OF 167 VANNED AND 143 UNVANNED GRADE SIX PUPILS IN ARITHMETIC

Sample	n_k	S_k	S_k/n_k	$n_k \log S_k/n_k$
Vanned Final Test	166	32796.611	197.570	381.090
Unvanned Final Test	142	29161.847	205.365	328380
Total	308	61968.458		709.470

M/c = 0.0483

TABLE XXVI

HOMOGENEITY OF VARIANCE OF 167 VANNED AND 143 UNVANNED GRADE SIX PUPILS IN READING

Sample	n_k	S_k	S_k/n_k	$n_k \log S_k/n_k$
Vanned Final Test	166	55604.204	334.965	419.366
Unvanned Final Test	142	41483.749	292.139	350.144
Total	308	97087.953		769.480

M/c = 0.214

TABLE XXVII

HOMOGENEITY OF VARIANCE OF 167 VANNED AND 143 UNVANNED GRADE SIX PUPILS IN LANGUAGE

Sample	n_k	S_k	S_k/n_k	$n_k \log S_k/n_k$
Vanned Final Test	166	102711.438	618.744	463.390
Unvanned Final Test	142	98985.539	697.081	403.746
Total	308	201696.977		867.136

$M/c = 0.0558$

The observed values of M/c for all subjects for both vanned and unvanned groups when compared to the values of significance of the chi-square distribution indicated that the null hypothesis, that variance in control and experimental groups are in effect the same, was supported.

The results of the analysis of covariance in arithmetic, reading and language for grade six pupils appear in Tables XXVIII, XXIX and XXX.

TABLE XXVIII

ANALYSIS OF COVARIANCE SUMMARY OF 167 VANNED AND 143 UNVANNED GRADE SIX PUPILS IN ARITHMETIC

Test	Property Tested	F Ratio	Significant Ratio 5%	Significant Ratio 1%	Result
F_1	Difference between groups Group means corrected for Group Regression	0.921	3.03	4.68	not significant
F_2	Difference between groups Group means corrected for Combined Regression	1.495	3.87	6.73	not significant
F_3	Difference between Group Regression	0.355	3.87	6.73	not significant

The results of the analysis of covariance indicated that there was no significant difference in arithmetic achievement between 167 vanned and 143 unvanned pupils as measured by the Stanford Achievement Test over a fourteen month interval.

TABLE XXIX

ANALYSIS OF COVARIANCE SUMMARY OF 167 VANNED AND 143 UNVANNED GRADE SIX PUPILS IN READING

Test	Property Tested	F Ratio	Significant Ratio 5%	Significant Ratio 1%	Result
F_1	Difference between groups Group means corrected for Group Regression	0.170	3.03	4.68	not significant
F_2	Difference between groups Group means corrected for Combined Regression	0.038	3.87	6.73	not significant
F_3	Difference between Group Regression	0.301	3.87	6.73	not significant

The results of the analysis of covariance indicated that there was no significant difference in reading achievement between 167 vanned and 143 unvanned pupils as measured by the Stanford Achievement Test over a fourteen month period.

TABLE XXX

ANALYSIS OF COVARIANCE SUMMARY OF 167 VANNED AND 143 UNVANNED GRADE SIX PUPILS IN LANGUAGE

Test	Property Tested	F Ratio	Significant Ratio 5%	Significant Ratio 1%	Result
F_1	Difference between groups Group means corrected for Group Regression	1.089	3.03	4.69	not significant
F_2	Difference between groups Group means corrected for Combined Regression	0.109	3.88	6.73	not significant
F_3	Difference between group regression	2.06	3.88	6.73	not significant

The results of the analysis of covariance indicated that there was no significant difference in language achievement between 167 vanned and 143 unvanned pupils as measured by the Stanford Achievement Test over a fourteen month period.

CHAPTER VII

ATTENDANCE OF VANNED AND UNVANNED PUPILS

One of the factors affecting pupil achievement is attendance. To determine whether there was any significant difference in attendance between the vanned and the unvanned groups at the grade two, four, and six levels, a study of attendance was carried out.

The computation for comparing differences between means was based on that of a critical ratio as outlined by Garrett.[15] In order that the analysis involving critical ratios be justified, a test of homogeneity of variances was made. This test was made according to the method outlined by Kenney and Keeping.[16] A summary of computations is contained in Table XXXI.

TABLE XXXI

SUMMARY OF TESTS OF HOMOGENEITY OF VARIANCE OF ATTENDANCE FOR GRADES TWO, FOUR AND SIX

Sample	F Ratio	Result
Grade 2	1.31	not significant
Grade 4	1.23	not significant
Grade 6	1.28	not significant

[15] H. E. Garrett. Statistics in Psychology and Education. Toronto: Longmans, Green and Company, 1953, p. 215.

[16] Kenny, op. cit., p. 257.

On the basis of these results the null hypothesis, that vanned and unvanned pupils could have come from populations of equal variance in attendance, was accepted. Therefore,the use of the critical ratio test for differences between attendance means was justified.

A summary of the results of the differences between mean attendance of vanned and unvanned groups for grades two, four, and six is given in Table XXXII.

TABLE XXXII

SUMMARY OF RESULTS OF TESTS MEASURING DIFFERENCES BETWEEN MEAN ATTENDANCE OF VANNED AND UNVANNED GROUPS

Sample	Difference	C.R.	Result
Grade 2	2.81	1.69	Not significant
Grade 4	1.42	1.163	Not significant
Grade 6	3.80	3.565	significant 1%

On the basis of these results it can be concluded that there was a significant difference in mean attendance favoring the unvanned group at the grade six level.

The fact that the vanned grade six pupils attended fewer days may be partly accounted for by the practice of keeping farm boys at home to assist with the seeding and harvesting operations. The conclusion that there were no significant differences in attendance between vanned and unvanned grade two and four groups is partial justification of vanning of rural pupils and the centralization of rural schools.

CHAPTER VIII

CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER STUDY

The results of the analysis of covariance have been summarized in a series of tables given below. A study of these tables will indicate the result of the covariance tests and also the degree to which the data satisfy the basic assumptions on which the analysis is based.

THE EFFECT OF VANNING ON ACHIEVEMENT OF GRADE TWO PUPILS IN ARITHMETIC AND READING

TABLE XXXIII

SUMMARY OF RESULTS FOR THE GRADE TWO GROUPS

Test	Arithmetic			Reading		
	Vanned	Unvanned	Level of Significance	Vanned	Unvanned	Level of Significance
Linear	yes	yes	-	yes	yes	-
Normal	yes	yes	-	yes	yes	-
Homoscedastic	no	yes	.05	yes	no	.05
Homogeneity of Variance	yes	yes	-	yes	yes	-
Test of Covariance		favor	.01		favor	.01

The above table indicates the validity of the assumptionsof

linearity, normality and homogeneity of the data for grade two in arithmetic and reading. The assumption of homoscedasticity for both groups in reading and arithmetic could not be considered to have been met. Since all conditions prerequisite to an analysis of covariance design had not been fully satisfied the results of the final analysis must be interpreted with some caution.

The results of the analysis of covariance indicated that there was a significant difference in pupil achievement at the grade two level in arithmetic and reading over the fourteen month period in favor of the unvanned group.

THE EFFECT OF VANNING ON ACHIEVEMENT OF GRADE FOUR PUPILS IN ARITHMETIC AND READING

TABLE XXXIV

SUMMARY OF RESULTS FOR THE GRADE FOUR GROUPS

Test	Arithmetic			Reading		
	Vanned	Unvanned	Level of Significance	Vanned	Unvanned	Level of Significance
Linear	yes	yes		yes	yes	
Normal	yes	yes		yes	yes	
Homoscedastic	no	yes	.05	yes	no	.05
Homogeneity of Variance	yes	yes		yes	yes	
Test of Covariance	favor		.01	no significant difference		

It appears from the table above that the test of homoscedasticity was the only assumption which could not be fully met. Again we must warn

that the results of the final analysis are to be interpreted with some reservation.

The covariance analysis indicated that there was a significant difference in arithmetic achievement at the grade four level favoring the vanned group as measured by the Stanford Achievement Test over a fourteen month period. However, for the same groups there was no significant difference in reading achievement.

THE EFFECT OF VANNING ON ACHIEVEMENT OF GRADE SIX PUPILS IN ARITHMETIC, READING AND LANGUAGE

TABLE XXXV

SUMMARY OF RESULTS FOR THE GRADE SIX GROUPS

Test	Arithmetic			Reading			Language		
	Vanned	Unvanned	Level of Significance	Vanned	Unvanned	Level of Significance	Vanned	Unvanned	Level of Significance
Linearity	yes	yes		no	yes	.05	no	yes	.01
Normality	yes	yes		yes	no	.05	no	no	.01
Homoscedasticity	no	no	.01	no	yes	.01	no	no	.01 .05
Homogeneity of Variance	yes	yes		yes	yes		yes	yes	
Test of Covariance	not significant			not significant			not significant		

It would appear that the distributions of grade scores in arithmetic, reading and language for grade six do not meet the assumptions of linearity, normality, and homoscedasticity as adequately as did the distributions for grades two and four.

The results of the grade six analysis of covariance test indicated that there were no significant differences in arithmetic, reading and language achievement as measured by the Stanford Achievement Test over a fourteen month period.

ATTENDANCE

The results of the tests measuring the difference of mean attendance between vanned and unvanned groups indicated that there was a significant difference between means of the control and experimental groups in grade six. No significant difference in mean attendance was evident for groups in grades two and four. The assumption of homogeneity of variance was considered valid on the basis of the test used.

DISCUSSION

The results of the covariance analysis at the grade two level indicated that there was a significant difference in arithmetic and reading achievement between 171 vanned and 144 unvanned pupils as measured by the arithmetic and reading sub-tests of the Stanford Achievement Test over a fourteen month interval. The results in both instances were in favor of the unvanned groups. The results were considered significant since the null hypothesis was rejected at the .01 level of

significance.

These results should be interpreted cautiously since the assumption of homoscedasticity was not fully met. The results indicated that the range of variability of the pupils' second testing scores was dependent upon the value of their initial test scores, and that this variability was not constant.

The following factors in varying degrees could have affected the results of the test of homoscedasticity:

1. The nature of the test.
2. The effects of increasing individual differences.
3. The effects of differentiated teaching.
4. The degree of teaching at home by the parents.

Since a pupil's achievement in arithmetic and reading might also be affected by intelligence and school attendance, it was found necessary to take these factors into consideration. It has been shown in this study that there were no significant differences in mean attendance between the vanned and unvanned groups. A separate study conducted by Dunlop, Harper and Hunka[17] indicated that there were no significant differences in intelligence between the two groups as measured by the Otis Quick Scoring Test of Mental Ability. The results of the covariance analysis therefore cannot be attributed to the factors of attendance and intelligence.

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[17]G.M. Dunlop, R.J.C. Harper and S. Hunka. "The Influence of the Time Spent in Busses Upon Achievement and Attendance of Pupils in Alberta Consolidated Schools." The Alberta Journal of Educational Research, Vol. III, No. 4, p. 172.

Assuming that the experimental design held constant all the important variables but that of vanning, it can only be concluded that the act of vanning and factors associated with vanning appear to be responsible for the differences observed. However, it is not possible to determine whether fatigue due to time on the van or lengthening of the school day, or psychological isolation from the home would have the greatest impact.

The results of the analysis of covariance at the grade four level indicated that there was a significant difference in arithmetic achievement between the vanned and unvanned groups as measured by the arithmetic sub-test of the Stanford Achievement Test. The results were in favor of the vanned group. However, there was no significant difference in reading achievement as measured by the reading sub-test of the Stanford Achievement Test.

Non-homoscedasticity in the distribution of the arithmetic scores of the vanned group and the reading scores of the unvanned group was observed. The caution necessary in the interpretation of the covariance analysis as mentioned in the case of grade two also applies here.

The superiority of the vanned group in arithmetic achievement cannot be attributed to a higher level of competence prior to the initial testing since the analysis of covariance, in effect, equated both groups to a common level of competency on the basis of the initial test results. Nor can the differences observed be attributed to differences in intelligence and attendance since it has already been indicated that these two factors were not operative at the grade four level in the

sample. However, this superior achievement in arithmetic may be attributed in part to the greater opportunities for children of this age group who live on farms to obtain a practical knowledge of arithmetic through their experiences. In this connection the difference between group means for total achievement, as reported by Hunka,[18] was almost significant at the 5% level in favor of the vanned group. It would seem tenable that a large portion of the almost significant difference could have been contributed by the arithmetic sub-test of the total battery.

There appears to be no significant difference in the reading achievement of vanned and unvanned pupils as measured by the reading sub-test of the Stanford Achievement Test. Consequently, it may be concluded with reasonable assurance that vanning does not have any recognizable affect on reading achievement at the grade four level.

On the basis of the analysis of covariance results of the arithmetic, reading and language sub-tests of the Stanford Achievement Test in grade six, there was little evidence to suggest that vanning had a deleterious affect upon achievement. This hypothesis is enhanced by the fact that there was a significant difference in mean attendance favoring the unvanned group. The fact that the vanned group generally speaking attended fewer days but obtained a level of achievement comparable to that of the unvanned is significant in itself.

In view of the fact that the distributions of scores in reading

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[18] S. Hunka. Master's Thesis, University of Alberta, 1957, p. 39.

and language could not completely satisfy the basic assumptions necessary for the analysis of covariance, it would appear that these sub-tests do not effectively measure achievement in Alberta schools at the grade six level. Part of the inadequacies observed in the distributions of grade scores in reading and arithmetic may be attributed to differences in curriculum between the Alberta sample and the group from which the norms were obtained.

On the basis of these results it can be concluded that transportation of pupils by bus from rural areas to consolidated schools does not adversely affect their achievement in arithmetic, reading and language at the grade six level when compared to the results of similar students who are not transported.

The results of this study indicated that transportation of grade two pupils produced a lowering effect upon their achievement in arithmetic and reading. It may be safe to assume that these same effects would be present to some degree at the grade one and possibly at the grade three level.

Although the results showed that vanning had a lowering effect upon achievement in the subjects tested at the grade two level, it was also shown that this situation was not evident at the grade four and six levels. It may be safely assumed that the disadvantages of vanning upon achievement appear to be present only during the lower elementary school years. The findings of this study would tend to endorse, in part, the practice of transporting pupils to centralized schools as followed by divisional boards in the Province of Alberta during the past twenty

years.

It is recommended that further research in the area of school vanning should attempt to determine the extent to which vanning affects pupils at the other grade levels and to isolate the factors responsible for lowering the level of achievement at the grade two level. Additional information could be obtained by tests measuring the degree of fatigue and the quality of adjustment of vanned pupils. Future studies related to achievement of vanned pupils should attempt to collect data regarding factors contributing to the lengthening of the school day. Measuring instruments, particularly in the fields of reading and language beyond the elementary grade level should be carefully selected with due regard to validity and statistical reliability.

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APPENDIX A

SAMPLE CALCULATION OF LINEARITY TEST

The standard deviations for the two variables of x and y were obtained from information of the correlation chart in the following manner:

$$S_u^2 = \frac{\Sigma f_u^2}{N} - \left(\frac{\Sigma f_u}{N}\right)^2$$

$$= \frac{817}{171} - \left(\frac{-9}{171}\right)^2$$

$$= 4.7750$$

$$= 4.7362 \quad \text{(Sheppard's correction for grouping)}$$

$$S_u = 2.117$$

$$S_v^2 = \frac{\Sigma f_y^2}{N} - \left(\frac{\Sigma f_y}{N}\right)^2$$

$$= \frac{1632}{171} - \left(\frac{+46}{171}\right)^2$$

$$= 9.4715$$

$$= 9.3882 \quad \text{(Sheppard's Correction for grouping)}$$

$$S_v = 3.064$$

The calculation of the correlation coefficient was made in the following manner.

$$S_{uv} = \frac{\Sigma U_y}{N} - \frac{\Sigma U \Sigma fv}{N^2}$$

$$= \frac{852}{171} - \left(\frac{-9}{171}\right)\left(\frac{46}{171}\right)$$

$$= 4,9966$$

$$r = \frac{S_{uv}}{S_u S_v}$$

$$= \frac{4.9966}{2.177 \times 3.064}$$

$$r = 0.749$$

The following procedure was used to calculate the correlation ratio.

$$E_{yx}^2 = \left[\Sigma (V^2/fv) - N\bar{u}^2\right] \Big/ NS_v^2$$

$$= 1018.240 - 12.374 \Big/ 1605.382$$

$$= .627$$

The sums of squares due to regression and from regression were calculated from the following formulae.

(1) Due to Regression $NSy^2r^2 = 8105.594$

(2) About the Regression $NS_y^2 (Eyx^2 - r^2) = 953.599$

Total $- NS_y^2 Eyx^2 = 9059.193$

The final analysis of the calculations was made by entering the results into the following table.

Variation	SS	df	MS
About Regression Line	953.599	12	79.467
Due to Regression Line	8105.594	157	51.628
Total	9039.193		

$$F = \frac{79.467}{51.628} = 1.539$$

The observed F value was then compared with the tabulated 5% level of significance in the F. table.

About Regression Line $NS_y^2 (E_{yx}^2 - r^2)$

$171 \times 84.494 \quad (0.627 - 0.561)$

$14448.474 \quad (0.066)$

953.599

Due to Regression $NS_y^2 r^2$

14448.474×0.561

$= 8105.594$

Total $NS_y^2 E_{yx}^2 \; 2$

$14448.474 \times 0.627 = 9059.193$

Variation	SS	df	MS
About Regression Line	953.599	12	79.467
Due to Regression	8105.594	157	51.628
Total	9039.193		

$P = 14 \qquad P - 2 = 12 \qquad n_1 = 12$

$N = 171 \qquad N - P = 157 \qquad n_2 = 157$

$$F = \frac{79.467}{51.628} \qquad \frac{1.82}{2.30}$$

$F = 1.539$

	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12					
	14	17	20	23	26	29	32	35	38	41	44	47	50	53	56	59	62					
14	80																					
13	77																1	1	13	169	12	156
12	74																					
11	71																					
10	68																					
9	65																					
8	62							2					1					3	24	192	13	89
7	59					1	2									1		4	28	196	12	84
6	56						2		2			1						5	30	180	14	84
5	53						1		1		1							3	15	75	9	45
4	50				1		1						1					3	12	48	7	28
3	47					3	4	2	1	1		1						12	36	108	21	63
2	44			1	2	3	5	1	2									14	28	56	9	18
1	41			1	4	17	3		2									27	27	27	3	3
0	38			8	12	10	1	2										33	0	0	-23	0
-1	35			2	13	4	2	1										22	-22	22	-13	13
-2	32		1	2	5	5												13	-26	52	-12	24
-3	29		2	7	7	1												17	-51	153	-27	81
-4	26		1	4	2													7	-28	112	-13	52
-5	23		3	2														5	-25	125	-13	65
-6	20			1														1	-6	36	-2	12
-9	11	1																1	-9	81	-4	36
	fu	1	7	28	46	44	21	8	8	1	1	2	2		1		1	171	461	1632	-9	852
	uf	-4	-21	-56	-46	0	21	16	24	4	5	12	14		10		12	-9				
	u^2f	16	63	112	46	0	21	32	72	16	25	72	98		100		144	817				
	V	-9	-27	-56	-40	22	58	23	26	3	5	8	12		7		13	46				
	uV	36	81	112	40	0	58	46	78	12	25	54	84		70		156	852				
	V^2/f	81·000	104·142	112·000	34·783	11·000	160·190	66·125	84·500	9·000	25·000	40·500	72·000		49·000		169·000	1018·240				

| | | |

APPENDIX B

SAMPLE CALCULATION OF THE TEST OF HOMOSCEDASTICITY

A group of observations are said to be homoscedastic when they distribute themselves with equal variance about the regression line Y on X.

The basic calculation from which M/c is obtained is as follows:

$$M = (2.303) \sum n_k \log_{10} \sum S_k / n_k - n_k - n_k \log_{10} (S_k/n_k)$$

$$c = 1 + \frac{1}{3(b-1)} \left\{ \sum \left(\frac{1}{n_k} \right) - \frac{1}{n} \right\}$$

Using the data of the correlation chart in Appendix A the analysis proceeds as follows:

$\sum x^2$	$\sum x$	$(\sum x)^2/n$	$\sum x^2 - (\sum x)^2 n$	n_k	S_k/n_k	$\log_{10} S_k/n_k$
4969	185	4889.29	79.71	6	13.29	1.123525
29187	873	27218.89	1968.11	27	72.89	1.862668
58708	1628	57617.04	1090.96	45	24.24	1.384533
69794	1738	68651.00	1143.00	43	26.58	1.424555
45996	872	44989.71	1006.29	20	50.31	1.701654
18155	373	17391.13	763.87	7	109.12	2.037904
18524	382	18240.50	283.50	7	40.50	1.607455
5345	103	5304.5	40.50	1	40.50	1.607455
6344	112	6272.0	72.00	1	72.00	1.857332
			6447.94	157		

$$\sum n_k \log_{10} S_k/n_k = 243.608$$

$$M = 2.303 \left[157 \log_{10} \frac{6447.94}{157} - 243.608\right]$$

$$M = 2.303 \left[157 \times 1.613525 - 243.608\right]$$

$$M = 2.303 \times 9.715$$

$$M = 22.374$$

$$c = 1 + \frac{1}{3(b-1)} \left\{\sum \frac{1}{n_k} - \frac{1}{n}\right\}$$

$$c = 1 + \frac{1}{24} \left\{2.5849 - 0.0064\right\}$$

$$c = 1 + 0.417 \ (2.5785)$$

$$c = 1 + 0.1075$$

$$c = 1.1075$$

$$M/c = 22.374/1.1075 = 20.20$$

$$df = 8$$

$$.01 = 20.090$$
$$.05 = 15.507$$

Since the value of M/c falls between the tabulated .05 and .01 level of significance at 8 degrees of freedom the distribution was considered to be non-homoscedastic.

APPENDIX C

SAMPLE CALCULATION OF THE TEST OF HOMOGENEITY OF VARIANCE

The test which determines whether two groups differ in variability centres about the calculation of M/c. This value is distributed according to the Chi-square distribution.

$$M = 2.303 \left[\sum n_k \log_{10} \frac{\sum S_k}{\sum n_k} - n_k \log_{10} S_k/n_k \right]$$

(i) For the vanned group

$$S_k = \sum y^2 - \frac{(\sum y)^2}{N}$$

$$= 15146.526$$

(ii) For the unvanned group

$$S_k = \sum y^2 - \frac{(\sum y)^2}{N}$$

$$= 15926.972$$

For the vanned group $n_k \log_{10} (S_k/n_k) = 331.477$

For the unvanned group $n_k \log_{10} (S_k/n_k) = 392.693$

The data was then summarized in the following table:

Sample	n_k	S_k	S_k/n_k	$n_k \log_{10}(S_k/n_k)$
vanned	170	15146.526	89.097	331.477
unvanned	143	15926.972	111.377	292.693
	313	31073.498		624.170

$$M = 2.303 \left[313 \log \frac{31073.498}{313} - 624.170 \right]$$

$$= 2.303 \left[0.839 \right]$$

$$= 1.932$$

$$c = 1 + \frac{1}{3(b-1)}\left\{\sum\left(\frac{1}{n_k}\right) - \frac{1}{n}\right\}$$

$$= 1 + \frac{1}{3}\left\{\frac{1}{170} + \frac{1}{143} - \frac{1}{313}\right\}$$

$$= 1.343$$

$$M/c = \frac{1.932}{1.003}$$

$$= 1.93$$

$$df = 1$$

$$\chi^2 \text{ at } .05 = 3.841$$

$$\chi^2 \text{ at } .01 = 6.635$$

Since the calculated value of M/c is smaller than the tabulated 5% level of the χ^2 distribution the null hypothesis of equal variance was accepted.

APPENDIX D

The following table was used to facilitate the calculation of the χ^2 test of normality.

Mid-Value	t	$\Delta\phi$ (t)	f_c		f_o		$(f_o-f_c)^2$	$(f_o-f_c)^2/f_c$
16	-2.86	0.00212	0.31	1.01	3		3.96	1.32
19	-2.46	0.00483	0.70					
22	-2.06	0.01275	1.84	6.13			0.02	0.00
25	-1.65	0.02977	4.29		6			
28	-1.25	0.05618	8.09	21.34	13	22	0.44	0.02
31	-0.85	0.09201	13.25		9			
34	-0.44	0.13231	19.05		22		8.70	0.46
37	0.00	0.17003	24.48		23		2.19	0.09
40	0.36	0.14058	20.24		27		45.70	2.26
43	0.77	0.13877	19.98		24		16.16	0.81
46	1.17	0.09965	14.35		11		11.22	0.78
49	1.57	0.06279	9.04		2		49.56	5.48
52	1.98	0.03436	4.95		2		8.70	1.76
55	2.38	0.01519	2.19					
58	2.78	0.00594	0.86	3.45	1			
61	3.18	0.00198	0.29					
64								
67								
70								
73	4.39	0.00074	0.11		1			
					144			= 13.59

df = 11 - 3 = 8
.05 = 15.507
.01 = 20.090

NORMAL

To calculate the theoretical normal distribution which is used for the goodness of fit test the following steps were taken:

(i) Calculation of the t values

$$t = \frac{y - \bar{y}}{Sy} \text{ where}$$

y - the mid-values of the score taken from a frequency distribution table.

$\bar{y}$ - the mean of the y values

S_y - the standard deviation of the y variable.

(ii) The theoretical probability of the number of cases falling between successive t values was then calculated.

(iii) The χ^2 test was then used to describe the goodness of fit between the observed values (f_o) and the theoretical value (f_e). The tabulated 5% value of the χ^2 distribution for 8 degrees of freedom is 15.507. Since the observed value of χ^2 is below the 15.507 there is no evidence to support the thesis that the observed distribution is not normal.

APPENDIX E

SAMPLE CALCULATION OF THE ANALYSIS OF COVARIANCE

Before the actual steps in the analysis of covariance were undertaken the sums of squares, cross products and means of the grade scores for the vanned and unvanned groups were computed. These values are tabulated in Table XXXVI.

TABLE XXXVI

SUMMARY OF PRELIMINARY COMPUTATION NECESSARY FOR THE ANALYSIS OF COVARIANCE

k	Group	Σx	Σy	Σx^2	Σy^2	Σxy	N	$\bar{x}$	$\bar{y}$
1	Vanned	4411	6603	120961	270115	178057	171	25.795	38.614
2	Unvanned	3742	5905	103609	258073	159576	144	25.986	41.007

The information from the above table was then used to calculate the variances and covariances within each group and the regression coefficients needed for equating both groups for initial test scores. The steps were as follows:

$$(1)\quad C_{12.1} = \Sigma x_{.1}\, y_{.1} - \frac{\Sigma x_{.1} \Sigma y_1}{N_1}$$

$$= 7730.491$$

$$(2)\quad C_{11.1} = \Sigma x_{.1}^2 - \frac{(\Sigma x_{.1})^2}{N_1}$$

$$= 7077.836$$

$$(3)_{22.1} = \Sigma y_{.1}^2 - (\Sigma y_{.1})^2$$

$$= 15146.526$$

$$(4)\quad b_{\cdot 1} = \frac{C_{12.1}}{C_{11.1}} = 1.09221$$

$$(5)\quad S_{3.1} = C_{22.1} - b_{\cdot 1}\, C_{12.1} = 6703.206$$

Similar procedures for the unvanned group were also effected. A summary of the values obtained for the vanned and unvanned groups appear in Table XXXVII.

TABLE XXXVII

SUMMARIZATION OF INITIAL STEPS IN THE ANALYSIS OF COVARIANCE

K	C_{11k}	C_{22k}	C_{12k}	b_k	S_{3k}
1	7077.836	15146.526	7730.491	1.09221	6703.206
2	6368.997	15926.972	6128.041	0.96216	10030.863
Σ	13446.833	31073.498	13858.53	(1.030617)	16734.069

Computations for variance between groups and for the total sample follow:

$$(1)\quad C_{11f} = \Sigma\, n_k\, (\bar{x}_{\cdot k} - \bar{x})^2$$

for k= 1 = 1.3242

k= 2 = 1.5277

$$C_{11f} = 2.8519$$

$$(2)\quad C_{22f} = \Sigma\, n_k\, (\bar{y}_{\cdot k} - \bar{y})^2$$

for k= 1 = 204.660

k= 2 = 242.986

$$C_{22f} = 444.646$$

(3) $C_{12f} = \sum n_k(\bar{x}_{.k} - \bar{x})(\bar{y}_{.k} - \bar{y})$

For k = 1 = 16.463
k = 2 = 19.267

$C_{12f} = 35.730$

(4) $b_f = \frac{C_{12f}}{C_{11f}}$

$= 12.328$

(5) $C_{120} = C_{12f} + \sum C_{12k}$

$= 13894.262$

(6) $C_{110} = C_{11f} + \sum C_{11k}$

$= 13449.685$

(7) $C_{220} = \sum C_{22k} + C_{22f}$

$= 31521.1448$

(8) $b_o = \frac{C_{120}}{C_{110}}$

$= 1.03305$

(9) For the whole sample the residual sums of squares are:

$S_o = C_{220} - b_o C_{120}$

(10) For between the groups the residual sums of squares are:

$S_1 = C_{22f} - b_f C_{12f}$

$= 0.0$

(11) For within the groups the residual sums of squares are:

$S_2 = C_{22w} - b_w C_{12w}$

$= 16790.618$

(12) The residual sums of squares within groups representing the difference between corrections made for group regression and combined regressions are:

$$S_4 = \sum (b_k - b_w)^2 \; C_{11k}$$

For k = 1 = 26.858

k = 2 = 29.851

S_4 = 56.709

TABLE XXXVIII

THE SUMMARY OF RESIDUAL SUMS OF SQUARES AS CALCULATED FOR THE ANALYSIS OF COVARIANCE

Variation	SS	df	
Within Groups S_3	16734.069	311	53.807
Between Regression S_4	56.709	1	56.709
Within Groups-combined regression S_2	16790.639	312	53.816
Between Groups from regression of Mean S_1	0.0	-	-
Difference b_u and b_f S_5	376.413	1	376.414
$S_o - S_2 = S_1 + S_5$	376.413	1	376.413
$S_o - S_3$	432.962	2	216.815
Total S_o	17167.031		

$F_1 = \frac{216.815}{53.807}$ df $n_1 = 2$

$= 4.029$ $n_2 = 312$

$F_2 = \frac{376.413}{53.816}$ $n_1 = 1$

$= 6.994$ $n_2 = 312$

$F_3 = \frac{56.709}{53.807}$ $n_1 = 1$

$= 1.059$ $n_2 = 311$

The F ratios were then compared to the desired level of significance in the F distribution table.

APPENDIX F

TABLE XXXIX

SUMMARY OF PRELIMINARY COMPUTATIONS FOR THE ANALYSIS OF COVARIANCE FOR GRADE TWO

Sample	Σx	Σy	Σx^2	Σy^2	Σxy
Vanned Arith.	4315	6253	110464	236380	160918
Unvanned Arith	3630	5372	93724	208376	138149
Vanned Reading	4411	6603	120861	270115	178057
Unvanned Reading	3742	5905	103609	258073	159576

TABLE XL

SUMMARY OF PRELIMINARY COMPUTATION FOR THE ANALYSIS OF COVARIANCE FOR GRADE FOUR

Sample	Σx	Σy	Σx^2	Σy^2	Σxy
Vanned Arith.	8613	11303	401049	698573	528349
Unvanned Arith	7801	9260	320605	551376	417740
Vanned Reading	8733	10864	433573	661560	528591
Unvanned Reading	6952	9024	323126	541224	412836

TABLE XLI

SUMMARY OF PRELIMINARY COMPUTATION FOR THE ANALYSIS OF COVARIANCE FOR GRADE SIX

	Σx	Σy	Σx^2	Σy^2	Σxy
Vanned Arith.	10804	13831	714152	1178285	911579
Unvanned Arith.	9262	11671	612370	981695	770538
Vanned Reading	10409	12644	685975	1012914	823398
Unvanned Reading	9073	10939	605562	878279	720998
Vanned Language	10537	12734	736121	1073698	854518
Unvanned Language	8835	10648	600373	891852	705856

TABLE XLII

SUMMARY OF THE MEANS FOR THE GRADE TWO PUPILS

Sample	$\bar{x}$	$\bar{y}$	$\bar{X}$	$\bar{Y}$
Vanned Arith.	25.234	36.567	25.222	36.905
Unvanned Arith.	25.208	37.306		
Vanned Reading	25.795	38.614	25.883	39.708
Unvanned Reading	25.986	41.007		

TABLE XLIII

SUMMARY OF THE MEANS FOR THE GRADE FOUR PUPILS

Sample	$\bar{x}$	$\bar{y}$	$\bar{X}$	$\bar{Y}$
Vanned Arith.	45.814	60.122	45.098	59.089
Unvanned Arith.	44.256	57.875		
Vanned Reading	46.452	57.872	45.072	57.150
Unvanned Reading	43.450	56.400		

TABLE XLIV

SUMMARY OF THE MEANS FOR THE GRADE SIX PUPILS

Sample	$\bar{x}$	$\bar{y}$	$\bar{X}$	$\bar{Y}$
Vanned Arith.	64.695	82.820	64.729	82.265
Unvanned Arith.	64.769	81.615		
Vanned Reading	62.329	75.713	62.845	76.074
Unvanned Reading	63.448	76.497		
Vanned Language	63.096	76.252	62.490	75.426
Unvanned Language	61.783	74.462		

The $\bar{x}$ and $\bar{y}$ values represent means determined from the pooled sample. In each case in order that the grade score mean be obtained the values tabulated above should be divided by ten.